CLAIMS

1. A method of making a spring wire comprising at least one layer (C) of a fiber wound helically on a cylindrical "primary" portion (12) of diameter equal to D, the tangent to said helix making an angle relative to the axis (100) of the primary portion (12) having a value β, said layer (C) also being suitable for being bonded to the primary portion (12) by a matrix (Rp), the fiber, once wound around the primary portion, presenting a cross-section that is substantially rectangular, of thickness E in the radial direction of the primary portion (12) and of width E' in the direction perpendicular to the tangent to the helix, the method consisting in preparing a funnel (13) of frustoconical shape, said funnel having a small opening (14) corresponding to the small base of the frustoconical shape, in preparing a supply (15) to deliver the fiber (Fb1), in connecting one of the ends (16) of said fiber to the primary portion (12), and in imparting rotary movement (R) to said supply (15) at a speed ω about the axis (100) of said primary portion (12), said primary portion being moved in translation (17) at a speed T through the funnel (13) along its axis going from its large opening (24) towards its small opening (14), the method being characterized by the fact that it further consists in causing said fiber (Fb1) to penetrate into the funnel (13) via its large opening corresponding to the large base of the frustoconical shape, the angle at the apex of said funnel (13) having a value that is substantially equal to 2β, the small base of the frustoconical shape of said funnel having a diameter equal to D+2E, the value ω of the speed in rotation of the supply (15) expressed in revolutions per second, and the value T of the speed in translation of the primary portion (12) expressed in meters per second being associated by the following relationship:

$$\omega = \frac{T}{D\pi\left[\tan\left(\frac{\pi}{2} - \beta\right)\right]}$$

2. A method according to claim 1, characterized by the fact that it consists in preparing X supplies (15-1, 15-2, ...) each of one fiber, one end of each fiber being connected to the primary portion (12), the X fibers penetrating into the funnel (13) via its large opening (24), and in driving said supplies in rotary movement (R) at the same speed of rotation of value ω about the axis (100) of the primary portion, while causing said primary portion (12) to move in translation at the speed of value T towards said small opening of the funnel, the number X of said supplies being equal to:

$$X = \pi \frac{D}{E} \sin\left(\frac{\pi}{2} - \beta\right)$$

3. A method according to claim 1 or claim 2, characterized by the fact that said movement in translation is selected from one of the following two kinds of movement: continuous translation; stepwise translation.

4. A method according to claim 3, characterized by the fact that stepwise translation is obtained by applying oscillating motion to said funnel (13) along its axis, the small opening (14) presenting a shape that is substantially cylindrical and including biting teeth on the surface of its inside wall.

5. A method according to any one of claims 1 to 4 for making a spring wire, the wire comprising "n" layers (C) of fibers (Fb) each having a thickness E and being wound in "n" helices on one another in coaxial manner, respectively in left-handed and in right-handed helices on a cylindrical "primary" portion (12) of diameter equal

to D, the tangents to said "n" helices making angles relative to the axis (100) of the primary portion having respective values β_1, β_2, ..., β_n progressing from $-\Delta-\gamma$ to $\Delta+\gamma$, said "n" layers (C) also being suitable for being bonded to one another and to the primary portion (12) by a matrix (Rp),

the method being characterized by the fact that it consists:

· in preparing a funnel (13) of frustoconical shape having an angle at the apex substantially equal to $2(\Delta+\gamma)$, said funnel having a small opening (14) corresponding to the small base of the frustoconical shape of diameter equal to D+2nE;

· in preparing "n" supplies (15) of fibers;

· in connecting one of the ends (16) of each of the "n" fibers to the primary portion (12), said "n" fibers penetrating into the funnel (13) via its large opening (24) corresponding to the large base of the frustoconical shape; and

· in driving the "n" supplies (15) in rotary movement (R) and in directions opposite to one another at respective speeds of rotation of values ω_1, ω_2, ..., ω_n about the axis (100) of the primary portion (12), said primary portion being moved in translation (17) through the funnel (13) along its axis going from its large opening (24) towards its small opening (14), the values ω_1, ω_2, ..., ω_n of the respective speeds of rotation of the "n" supplies (15) being functions of the value T of the speed in translation of the primary portion.

6. A method according to any one of claims 1 to 5, characterized by the fact that it further consists in filing said funnel (13) in a liquid matrix (Rp) prior to setting at least one supply (15) in rotation and to setting the primary portion into translation.

7. A method according to claim 5 or claim 6, characterized by the fact that it consists in surrounding said small opening (14) of the funnel (13) with a sleeve (20) having an inlet orifice of substantially the same diameter as said small opening, and an outlet orifice (20) of a shape adapted to the shape of the section desired for the wire.

8. A wire for making a spring, the wire being obtained by the method according to at least one of claims 1 to 7, said wire being substantially cylindrical in shape (FR) and including at least a first plurality of layers (C_{x-1}, C_x, ..., C_n) of wound fibers (Fb), said layers being situated on one another and being impregnated with a matrix (Rp), the wire being characterized by the fact that said first plurality of layers comprises at least two layers (C_{x-1}, C_x) of fibers situated on each other, the fibers of these two layers being wound in opposite directions relative to each other in two helical pitches about a common axis (10), respectively left-handedly and right-handedly, the tangents to these two helices forming angles relative to said axis (10) with respective values β_{x-1} and β_x that are substantially equal respectively to $\Delta+k\gamma$ and $-\Delta-k\gamma$, where γ is a function of the value of the modulus of elasticity for the spring to be obtained and "k" is a factor of having a value lying in the range zero to one, the value Δ being no greater than substantially 44.6°.

9. A wire according to claim 8 for making a spring suitable for working in compression, the wire being characterized by the fact that said first plurality of layers comprises an even number "n" of layers C_1, ..., C_n of fibers (Fb) situated on one another, the layer C_1 being the closest to said axis (10), said fibers being wound in helices that are all coaxial about said axis (10), the helices of two consecutive layers C_1, C_2; ..., C_{n-1}, C_n

being respectively left-handed and right-handed, and the tangents to these helices forming angles relative to said axis having values respectively equal to:

$-\Delta$ and Δ for the first pair of layers C_1, C_2;

$-(\Delta+2\alpha)$ and $+\Delta+2\alpha$ for the second pair of layers C_3, C_4;

$-(\Delta+4\alpha)$ and $\Delta+4\alpha$ for the third pair of layers C_5, C_6; and so on up to $-(\Delta+(n-2)\alpha)$ and $\Delta+(n-2)\alpha$ for the $(n/2)^{th}$ pair of layers C_{n-1}, C_n;

where Δ is no greater than substantially 44.6°, and $-\alpha$ is substantially equal to $\frac{\gamma}{n-2}$.

10. A wire according to claim 8 for making a spring suitable for working in compression, the wire being characterized in that said first plurality of layers comprises "n" layers C_1, ..., C_n of fibers (Fb) situated on one another, the layer C_1 being the closest to said axis (10), the fibers being wound in helices that are all coaxial about said axis (10), the helices of two consecutive layers being respectively left-handed and right-handed, and the tangents to the helices forming angles relative to said axis having values respectively equal to:

$$-\Delta,\ +\Delta+\alpha,\ -(\Delta+2\alpha),\ \Delta+3\alpha,\ -(\Delta+4\alpha),\ \Delta+5\alpha,\ \ldots,\ -(\Delta+(n-2)\alpha),\ \Delta+(n-1)\alpha;$$

where Δ is no greater than substantially 44.6°, and $-\alpha$ is substantially equal to $\frac{\gamma}{n-1}$.

11. A wire according to claim 8 for making a spring suitable for working in traction, the wire being characterized by the fact that said first plurality of layers comprises an even number "n" of layers C_1, ..., C_n of fibers (Fb) situated on one another, the layer C_1 being the closest to said axis (10), said fibers being wound in helices that are all coaxial about said axis (10), the

helices of two consecutive layers C_1, C_2; ..., C_{n-1}, C_n; being respectively left-handed and right-handed, and the tangents to the helices forming angles with said axis having values respectively equal to:

Δ and $-\Delta$ for the first pair of layers C_1, C_2;

$\Delta+2\alpha$ and $-(\Delta+2\alpha)$ for the second pair of layers C_3, C_4;

$\Delta+4\alpha$ and $-(\Delta+4\alpha)$ for the third pair of layers C_5, C_6; and so on up to $\Delta+(n-2)\alpha$ and $-(\Delta+(n-2)\alpha)$ for the $(n/2)^{th}$ pair of layers C_{n-1}, C_n;
where Δ is no greater than substantially 44.6°, and $-\alpha$ is substantially equal to $\frac{\gamma}{n-2}$.

12. A wire according to claim 8 for making a spring suitable for working in traction, characterized by the fact that said first plurality of layers comprises "n" layers C_1, ..., C_n of fibers (Fb) situated on one another, the layer C_1 being the closest to said axis (10), the fibers being wound in helices that are all coaxial about said axis (10), the helices of two consecutive layers being respectively left-handed and right-handed, and the tangents to the helices forming angles with said axis having respective values equal to:

$$\Delta,\ -(\Delta+1\alpha),\ \Delta+2\alpha,\ -(\Delta+3\alpha),\ \Delta+4\alpha,\ -(\Delta+5\alpha),\ \ldots,\ \Delta+(n-2)\alpha,\ -(\Delta+(n-1)\alpha);$$

where Δ is no greater than substantially 44.6°, and $-\alpha$ is substantially equal to $\frac{\gamma}{n-1}$.

13. A wire according to any one of claims 8 to 12, characterized by the fact that said first plurality of layers is situated at the periphery of the cylinder (FR).

14. A wire according to any one of claims 8 to 13, characterized by the fact that it further comprises a central core (Ac).

15. A wire according to claim 14, characterized by the fact that said central core (Ac) is made of a material having a low modulus of elasticity in twisting.

16. A wire according to claim 14, characterized by the fact that said central core (Ac) is made of a material having a low modulus of elasticity in twisting and a second plurality of layers of fibers situated concentrically on one another at the periphery of the central core, the fibers being wound in helices that are coaxial and the tangents to said helices forming angles with the axis (10) of the helices having absolute values that are no greater than substantially 44.6°.

17. A wire according to claim 16, characterized by the fact that in the second plurality of layers of fibers (Fb), the number of left-handed helices is equal to the number of right-handed helices.

18. A wire according to any one of claims 8 to 17, characterized by the fact that it further comprises a protective sheath (11) surrounding the outside and in contact with the last layer (C_n) of the first plurality of layers of fibers (Fb).

19. A wire according to any one of claims 8 to 18, characterized by the fact that said fibers are glass fibers and said matrix (Rp) is a polymerizable resin.

20. A wire according to any one of claims 8 to 19, characterized by the fact that the layer situated at the periphery of the cylinder (FR) is thicker than the layer situated inside.

21. A wire according to any one of claims 8 to 20, characterized by the fact that the value Δ for the layer

(C_{x-1}) of the layer closest to said axis (10) is greater than the value Δ for the layer (C_x) closest to the periphery of the cylinder (FR).

22. A wire according to claim 21, characterized by the fact that it has about ten layers in said plurality (C_1, ..., C_n), said value Δ decreasing substantially continuously from substantially 44.6° to 42° on going from the first layer (C_1) at the central core to the last layer (C_n) at the periphery.